E. Find the value of a that makes each number sentence true.

1. $a^{12} = 531,441$ **2.** $a^9 = 387,420,489$ **3.** $a^6 = 11,390,625$

F. Find a value for a and values for the missing digits to make each number sentence true. Explain your reasoning.

1. $a^7 = \_\_\_\_\_3$ **2.** $a^8 = \_\_\_\_\_1$

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5.2 Operating With Exponents

In the last problem, you explored patterns in the values of a^x for different values of a. You used the patterns you discovered to make predictions. For example, you predicted the ones digit in the standard form of 4^{12}. In this problem, you will look at other interesting patterns that lead to some important properties of exponents.

Getting Ready for Problem 5.2

- Federico noticed that 16 appears twice in the powers table. It is in the column for 2^x, for $x = 4$. It is also in the column for 4^x, for $x = 2$. He said this means that $2^4 = 4^2$. Write 2^4 as a product of 2's. Then, show that the product is equal to 4^2.
- Are there other numbers that appear more than once in the table? If so, write equations to show the equivalent exponential forms of the numbers.

Problem 5.2 Operating with Exponents

Use properties of real numbers and your table from Problem 5.1 to help you answer these questions.

A. 1. Explain why each of the following statements is true.

a. $2^3 \times 2^2 = 2^5$ **b.** $3^4 \times 3^3 = 3^7$ **c.** $6^3 \times 6^5 = 6^8$

2. Give another example that fits the pattern in part (1).

3. Complete the following equation to show how you can find the exponent of the product when you multiply two powers with the same base. Explain your reasoning.

$$a^m \times a^n = a^{\square}$$

B. 1. Explain why each of the following statements is true.

a. $2^3 \times 3^3 = 6^3$ **b.** $5^3 \times 6^3 = 30^3$ **c.** $10^4 \times 4^4 = 40^4$

2. Give another example that fits the pattern in part (1).

3. Complete the following equation to show how you can find the base and exponent of the product when you multiply two powers with the same exponent. Explain your reasoning.

$$a^m \times b^m = \underline{\ ?\ }$$

C. 1. Explain why each of the following statements is true.

a. $4^2 = (2^2)^2 = 2^4$

b. $9^2 = (3^2)^2 = 3^4$

c. $125^2 = (5^3)^2 = 5^6$

2. Give another example that fits the pattern in part (1).

3. Complete the following equation to show how you can find the base and exponent when a power is raised to a power. Explain.

$$(a^m)^n = \underline{\ ?\ }$$

D. 1. Explain why each of the following statements is true.

a. $\frac{3^5}{3^2} = 3^3$ **b.** $\frac{4^6}{4^5} = 4^1$ **c.** $\frac{5^{10}}{5^{10}} = 5^0$

2. Tom says $\frac{4^5}{4^6} = 4^{-1}$. Mary says $\frac{4^5}{4^6} = \frac{1}{4^1}$. Who is correct and why?

3. Complete the following equation to show how you can find the base and exponent of the quotient when you divide two powers with the same base. (Assume a is not 0.) Explain your reasoning.

$$\frac{a^m}{a^n} = \underline{\ ?\ }$$

E. Use the pattern from Question D to explain why $a^0 = 1$ for any nonzero number a.

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